

Fish Species Composition, Timing and Distribution in Nearshore Marine Waters: A Synopsis of 2001-2002 Beach Seining Surveys in King County, WA

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Abstract

Although historic fish surveys have been conducted in Central Puget Sound, there has never been a systematic collection of data to determine baseline composition, timing and distribution of nearshore marine fishes in King County. Furthermore, little is known about juvenile salmon timing, distribution and other life history characteristics in Puget Sound nearshore marine waters. Therefore, the purpose of this study was to establish a baseline and begin to fill critical data gaps on fish species composition, timing and distribution in nearshore waters throughout King County, Washington. Beach seining surveys were conducted from May through October in 2001 and 2002. Twelve sites were sampled consistently during 2001, with seven of the 12 sites sampled consistently during 2002. An additional six sites were sampled periodically during the 2002 sampling period. All fish captured were identified and enumerated. All salmonids and at least a sub-sample of all other species were measured in length to the nearest millimeter. Salmonids were also weighed in 2002 and a sub-sample of salmonids (primarily juvenile chinook) was lavaged and stomach contents preserved for dietary analysis. Salmonids were checked for coded wire tags and pit tags. Quantitative and qualitative habitat data were also collected from each of the sampling sites. Results on species composition, timing, distribution, growth, diet and relationships to habitat variables will be presented.

Introduction

Puget Sound supports more than 200 species of marine fishes, yet historical data regarding fish species composition in nearshore marine waters are very limited. In particular, comprehensive nearshore fish surveys in King and southern Snohomish Counties have never been conducted to determine fish species composition, timing, distribution, and habitat utilization. Such information is critical for establishing a biological baseline that may be used for monitoring and assessment, environmental evaluations and for informing resource management decisions. Furthermore, the extensive alteration and degradation of nearshore ecosystems and the Endangered Species Act (ESA) listings of Puget Sound chinook salmon and bull trout have increased our need for an improved understanding of the marine life phases of salmonids and the implications for other marine fishes. This information is especially important for expanding our knowledge and informing watershed planning, wastewater planning, salmon recovery planning and other resource management efforts.

While a number of studies (e.g., Fresh *et al.* 1981; Simenstad *et al.* 1982; Healy 1982; and others) provide the basis of our understanding of salmonid early marine life history, few studies have surveyed outside of river-mouth estuaries and have not been conducted in the geographic area of interest for this study (i.e., King and Snohomish Counties). Saltwater habitats used by anadromous salmonids provide a critical component of their life histories (Thom 1987; Simenstad *et al.* 1991; Spence *et al.* 1996). In the Puget Sound estuary, adults use nearshore marine waters for migration and feeding, while juveniles are known to depend upon nearshore waters for migration, feeding and refuge. The estuarine environment is also an important physiological transition area for juvenile chinook and other salmonid smolts (Healy, 1980). Furthermore, nearshore ecosystems provide important prey production functions in addition to critical nursery habitat for a broad range of other fishes and invertebrates. Most of what we know and don't know about salmon and other fishes in the King and south Snohomish Counties' nearshore environment is summarized in Williams *et al.* (2001).

In an effort to improve our understanding of nearshore fish species composition, the King County Department of Natural Resources and Parks conducted beach seine surveys in 2001 and 2002. The purpose of this study was primarily to learn more about the timing, distribution and species composition of nearshore marine fishes, especially juvenile salmonids and, secondarily, to learn more about habitat utilization. An emphasis was placed on learning more about juvenile salmonid life histories. Therefore, additional data were collected to determine salmonid dietary composition, size classes, weights, and the relative composition of hatchery and wild fish. The specific objectives of this study included the following:

1. Sample a broad geographic area within King and south Snohomish Counties to determine differences in fish species composition (timing, distribution and abundance).

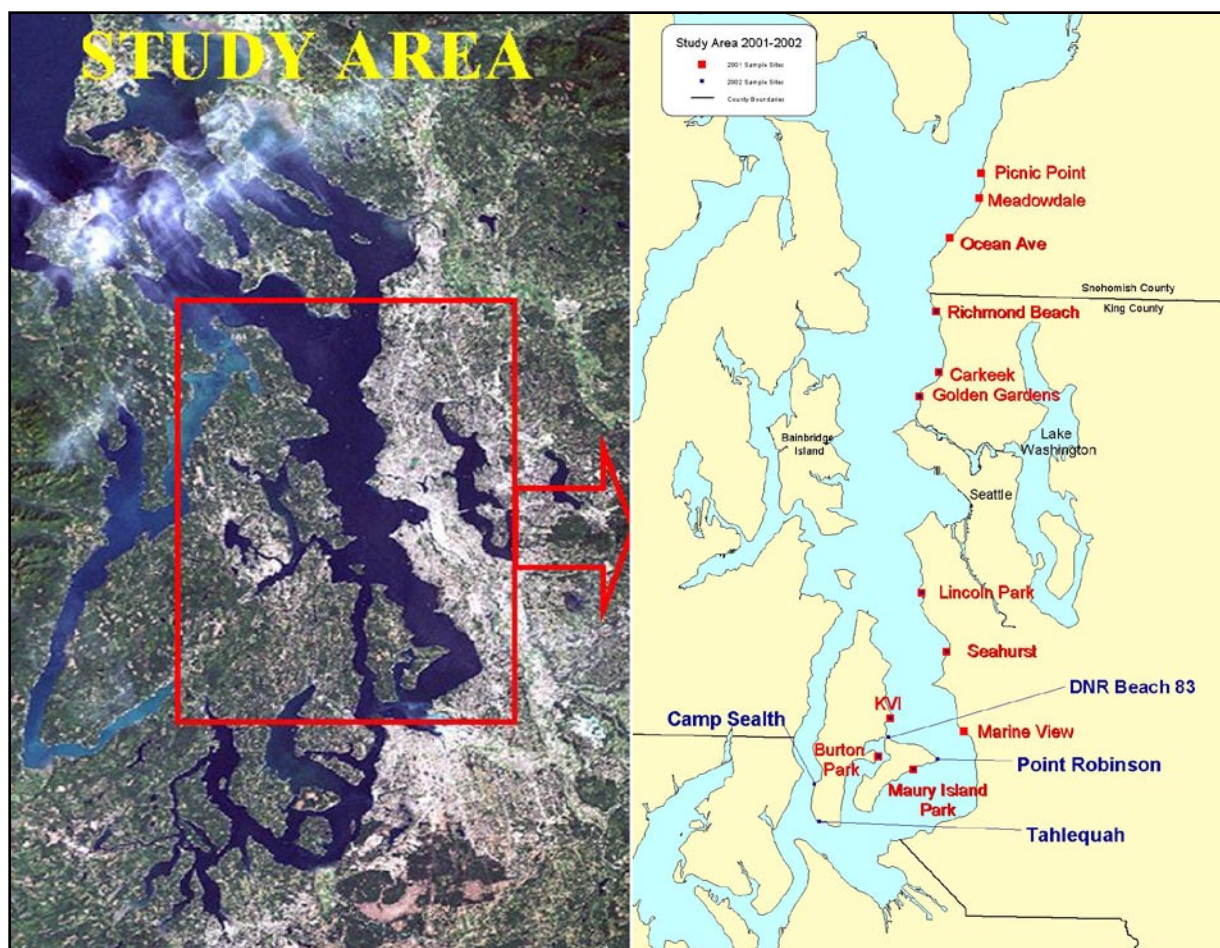


Figure 1. Study area and beach seining survey sites in 2001 and 2002.

2. Develop a standard for sampling, data collection and characterizing/classifying habitat type that could serve as a basis for future studies, comparison to other sampling efforts around Puget Sound and help in distinguishing differences in fish species composition.
3. Measure a subsample of all species to determine size classes of individual species utilizing nearshore marine waters.
4. Measure temporal and spatial distribution of nearshore fishes.
5. Collect gut contents of juvenile salmonids to determine prey composition and important prey items.
6. Distinguish adipose fin-clipped from non-clipped fish to help distinguish hatchery from possible wild fish.
7. Identify and collect coded wire tagged (CWT) salmonids to help distinguish hatchery from wild fish and determine point of origin/release, distribution, movement patterns, time at large and growth.

The data collected during this two-year study are currently being analyzed and reports are in preparation. Therefore, the purpose of this report is simply to inform other resource managers and interested parties of the work conducted by providing a synopsis of our methods, preliminary results and expected future results. [NOTE: Additional data collected under other King County beach seining survey programs (i.e., Core Areas Study and Bull Trout Studies), which began earlier (i.e., April-May, 2002) and were conducted in the same geographic area will be merged with the data from these beach seining surveys to capture earlier fish species composition. However, this information is not reported here.]

Methods

Beach seining surveys were conducted bi-weekly in marine nearshore waters at a total of 16 preselected sites throughout south Snohomish and King Counties (Figure 1). Sampling began in May of each year and continued into October in 2001 and December in 2002. The locations of sampling sites varied between years. Of the 12 sites sampled during 2001 and 12 sites sampled during 2002, 8 were identical for both years (Figure 1). Each site was sampled during daylight hours at tidal elevations that varied by the date and time of day. No effort was made to sample at preselected tidal elevations

(i.e., low tide) in order to detect differences in species composition at various tidal elevations. Early in the 2001 sampling period (i.e., May and June, 2001), three non-overlapping sets of the beach seine were made at each site. During the remainder of the study period, two non-overlapping sets were made at each site to enable us to complete three site surveys within a single day.

The beach seine (net) (commonly called a “Puget Sound beach seine”) used for this study was designed according to the specifications in *Puget Sound Estuary Program, Estuary Habitat Assessment Protocol* (Simenstad *et al.* 1991). The gear and sampling procedure were identified prior to field sampling as the standard for shallow, nearshore fish sampling in Puget Sound. The equipment consisted of a 37-meter long by 2-meter high, floating beach seine with tapered wings (2.56 cm stretch mesh) and a bag (0.6 m wide by 2.4 m deep by 2.3 m long, 0.6 cm stretch mesh) centered between the wings. Thirty-meter haul lines were attached to a harness at the ends of the wings. The net was set parallel to shore using a motorized vessel in the following manner: A person standing at the water line on the beach would hold one end of the haul line as the boat backed away from and perpendicular to shore, feeding out the line until the boat was 30-meters from shore. The boat was then turned parallel to shore and the net was released (set) as the boat ran parallel to shore. Once all of the net was released, the haul line at the other end of the net was returned to another person standing on the shore, approximately 40 meters down the beach from the first person. The haul lines were then pulled simultaneously, at an equal rate, and at a slightly oblique angle to form a wide arch of the net passing through the water and toward shore at a rate of approximately 10m/min. When the net was approximately 10 meters from shore, the individuals retrieving the net at each end would approach one another so the net opening closed to approximately 12 meters as the landward ends of the wings touched the beach. The wings were then drawn closer to within approximately 3 meters as the wings were drawn up onto the beach, making sure the lead line remained on the bottom and forcing all fish down the wings and into the bag. Once the lead line along the bag of the net reached the beach, the lead line and float lines were lifted simultaneously. Any fish remaining in the wings were worked down into the bag and the bag was pulled back out into approximately 0.5-meter depth of water to maintain a sufficient amount of water in the bag for the catch. Debris and fish were removed from the bag, with the fish being transferred to 5-gallon buckets of fresh seawater. All fish were identified to the lowest taxonomic classification that could be made with confidence and then counted. In 2001, a minimum of 10 fish of each species were retained for measurements of fork length or total length, depending upon the species. In 2002, it was determined that a minimum of 30 individual fish of each species would be retained for measurements (or all fish if individual species counts were less than 30) to improve statistical robustness.

The catch was transferred in buckets of seawater to a processing station, which was set up on the beach prior to deploying the seine. At this station, fish were maintained in aerated buckets of seawater until they could be measured. If necessary (i.e., during warm weather, or if processing took a long period of time), water was exchanged with fresh seawater to maintain oxygen levels and cool water temperature. A representative, random subsample of each species were measured on a wetted measuring board, with the length (total or fork, depending upon the species) called out to a data recorder. All data were recorded on preprinted waterproof (“Rite-in-the-Rain”) data sheets. Fish were allowed to recover in an aerated 30-gallon cooler of fresh seawater and subsequently released alive away from the area where a subsequent set of the net would be made.

For salmonids captured in the seine, processing required the collection and recording of additional data. Salmonids were usually processed first because they are typically more sensitive to handling and required more recovery time. Individual salmonids were immersed in a bath of fresh seawater that contained a mild anesthetic, MS-222 (tricaine), to sedate them prior to taking measurements, or performing gastric lavage (see below). Once sedated, salmonids were identified to species, measured (FL) and allowed to recover in the aerated recovery tank. In 2002, all sub-sampled salmonids were also weighted to the nearest 0.1 gram on an OHAUS Scout II digital scale. All chinook and coho salmon were checked for adipose fin presence or absence (i.e., clipped or unclipped) and chinook were checked for coded-wire tags using a Northwest Marine Technologies (NMT) magnetometer. In 2002, salmonids were also checked for PIT (Passive Integrated Transponder) tags using a handheld, 134.2 KHz Destron-fearing TX1400BE PIT tag reader. Coded-wire tagged fish were retained, labeled (date, location, set number, sample number) and preserved for transport to the Washington Department of Fish and Wildlife in Olympia for tag extraction and decoding. Once decoded, recapture position was mapped to show spatial distribution and movement patterns of coded-wire tagged fish.

Early in the 2001 sampling season, a sub-sample of whole salmonids were collected for dietary analysis. Fish were identified, measured, labeled and preserved for later stomach removal and analysis of stomach contents. This procedure was replaced with gastric lavage to avoid sacrificing fish. Gastric lavage is a procedure used to flush the stomach contents out of the foregut of the anesthetized fish. A 60 cc syringe fitted with a blunt needle was filled with filtered seawater. The

needle was then carefully inserted along the roof of the mouth, down the esophagus and into the foregut. Seawater was then forced into the gut, which flushes stomach contents out through the mouth and into a sample collection container. The samples were then labeled, preserved with 90% ethanol and archived for later analysis. Lavaged fish were allowed to fully recover in the recovery tank and were then released back into Puget Sound at the sampling location. Once lavage equipment was available in the field, fish were only intentionally sacrificed if they were to be sent for CWT analysis.

Initially, whole fish were labeled, bagged and placed in a cooler with dry ice. They were later transferred to a freezer for temporary storage. Fish that were coded-wire tagged had stomachs removed, labeled, preserved in ethanol and archived for later dietary analysis. Whole, non-coded-wire tagged fish collected for dietary analysis were placed in 10 percent solution of buffered formaldehyde and sent with other preserved samples (i.e., stomachs and lavaged) to the University of Washington for analysis. In 2002, the use of dry ice and freezing samples as a method of preservation was changed to preserving whole, CWT fish and lavage samples in ethanol.

In addition to fish-catch data, site-specific physical habitat and water quality data (i.e., water temperature, substrate type, and aquatic vegetation) were also collected and recorded on preprinted waterproof data sheets in an effort to quantitatively or qualitatively describe and characterize habitat. An individual datasheet was completed for each beach seine haul in a manner that would allow a distinction between each location, date and set. Each set location was recorded by taking Global Positioning System (GPS) coordinates in the center of the sampling location.

Results

A total of 16 individual sampling locations were surveyed in 2001 and 2002, with 12 sites sampled in each year and 8 sites sampled in both years (Figure 1). Of the 481 sets made during the study period, the total number of sets made per site ranged from 1 to 51 with 0 to 7 hauls made per site for each month of sampling (Table 1). During this study, a total of 71,317 individual fish were captured, representing 52 species (Tables 2 and 3). The total number of fish caught at each site ranged from 9 (at Talequah Pt.) to 9692 at Burton Park. However, these numbers do not reflect effort or species diversity. The number of species represented at each site and the number of individuals of a particular species (species diversity and abundance) varied geographically and throughout the study period, but the significance of these findings has yet to be determined.

Salmonids were captured throughout the study period. A total of 7848 salmonids were caught during the study, representing eight species. Chum were the most abundant salmonid captured ($n=4733$), followed by chinook ($n=2172$), coho ($n=468$), cutthroat trout ($n=275$), sockeye ($n=116$), pink ($n=63$), steelhead ($n=9$), char ($n=1$) and Atlantic salmon ($n=1$) (Tables 2&3). The highest number of salmonids was found at Lincoln Park ($n=1688$), with the lowest number found at Telaquah ($n=2$). The highest numbers of salmonids were captured earlier in the sampling period (i.e., May, June, July) and decreased throughout the remainder of the study period. Chinook and cutthroat catches continued, although they were variable in count, through most of the study period (Figures 2&3).

To help make a distinction between hatchery and “wild” salmonids, we noted whether fish had adipose fins intact (unclipped), or were removed (clipped) and if a coded-wire tag (CWT) was detected. **Note that the use of the term “wild” refers to salmonids which were not adipose fin clipped, or for which no coded-wire tag was detected.** Therefore, these fish are **presumed wild** and does not account for hatchery fish, which have no external markings or internal tags. Of the 2172 chinook sampled, 1790 records were taken to make the distinction between hatchery and wild fish (Tables 4 and 5). During the study period we recorded 1042 clipped chinook, of which 137 were coded-wire tagged and 835 were not coded-wire tagged. In addition, we recorded 748 unclipped chinook, of which 118 were tagged and 650 were not tagged. Of the 397 coho captured, we recorded 99 clipped and 298 unclipped fish (Tables 4 and 5). Chinook sizes ranged from 58mm to 328mm, with the majority of fish ($n=1069$) falling in the 80-110 mm size range. Coho sizes ranged from 34mm to 540mm, with the majority of fish ($n=236$) falling in the 100-140mm size range.

Table 1. Number of beach seine sets per site, by month in 2001 and 2002.

	May-01	May-02	Jun-01	Jun-02	Jul-01	Jul-02	Aug-01	Aug-02
Carkeek	6	2	4	4	3	4	4	4
Richmond Beach	6	0	4	4	4	5	3	5
Meadowdale	6	0	4	0	4	0	4	0
Ocean Ave	6	0	4	0	4	0	3	0
Picnic Point	6	0	4	0	4	0	5	0
Golden Gardens	3	2	4	6	4	7	4	4
Lincoln Beach	3	2	7	4	4	6	4	4
Seahurst Park	3	2	8	4	4	6	5	4
Marine View	3	0	5	0	4	0	4	0
KVI	6	2	4	4	4	4	4	4
Maury Island Park	5	2	4	4	4	4	3	4
Burton	3	2	4	2	4	0	3	0
DNR Beach 83	0	0	0	2	0	1	0	0
Point Robinson	0	0	0	0	0	0	0	1
Camp Sealth	0	0	0	0	0	2	0	2
Talequah Point	0	0	0	0	0	0	0	1
Totals:	56	14	56	34	47	39	46	33

	Sep-01	Sep-02	Oct-01	Oct-02	Total 01	Total 02	Totals
Carkeek	3	4	2	4	22	22	44
Richmond Beach	4	6	1	6	22	26	48
Meadowdale	4	0	2	0	24	0	24
Ocean Ave	4	0	2	0	23	0	23
Picnic Point	4	0	2	0	25	0	25
Golden Gardens	4	6	2	4	21	29	50
Lincoln Beach	4	6	1	5	23	27	50
Seahurst Park	4	6	1	4	25	26	51
Marine View	4	0	1	0	21	0	21
KVI	5	5	4	5	27	24	51
Maury Island Park	4	4	5	4	25	22	47
Burton	4	1	2	0	20	5	25
DNR Beach 83	0	0	0	0	0	3	3
Point Robinson	0	3	0	6	0	10	10
Camp Sealth	0	2	0	2	0	8	8
Talequah Point	0	0	0	0	0	1	1
Totals:	48	43	25	40	278	203	481

Although no PIT tags were detected in our samples, we detected 278 coded-wire tagged fish during this study (chinook plus coho). A total of 278 CWT samples (255 chinook and 23 coho) were collected and subsequently decoded by the WDFW decoding labs in Olympia. The coded-wire tag data, in conjunction with the recapture data (i.e., location, length and weight) were used to estimate time at large, growth, general direction/patterns of movement and distance traveled. The development of this mark-recapture data has enabled us to determine that the CWT fish found in the study area came from 22 different hatcheries located in 13 watersheds (WRIA's 1, 3, 4, 5, 7, 8, 9, 10, 11, 13, 14, 15, 18) (Tables 4 and 5). In addition, juvenile salmonids showed patterns of movement in all directions, including; South-North, North-South, East-West and West-East (this includes movement across the open, deeper waters of Puget Sound) (Figure 4).

Table 2. Summary of all fish caught by site in 2001.

		Picnic Point	Meadowdale	Ocean Avenue	Richmond Beach	Carkeek Park	Golden Gardens
Salmon	Chum	66	57	204	677	68	141
	Sockeye	0	2	0	38	1	67
	Cutthroat	45	120	1	2	2	2
	Steelhead	1	1	0	1	0	0
	Chinook	22	63	31	60	55	35
	Coho	30	16	3	23	12	12
	Atlantic Salmon	0	0	0	0	0	1
	Total Salmonids	164	259	239	801	138	258
Perch	Shiner perch	2801	2749	5241	1310	665	451
	Striped perch	35	17	58	22	1	66
	Pile perch	18	3	10	3	0	0
Flatfish	English sole	259	192	479	80	55	93
	Rock sole	122	262	32	18	32	5
	Starry flounder	65	25	9	1	28	33
	Speckled sanddab	35	48	11	1	8	39
	CO sole	2	9	11	0	1	3
	Sand sole	6	0	0	0	0	0
	Flathead sole	0	0	0	0	3	0
	Pacific sanddab	0	0	0	0	8	0
	Sanddab spp.	1	0	0	0	0	0
	Flatfish spp.	0	44	0	55	0	0
Sculpin	Staghorn sculpin	51	54	152	48	58	57
	Great sculpin	13	37	11	2	2	16
	Northern sculpin	2	3	0	1	2	14
	Buffalo sculpin	9	20	0	0	1	3
	Silverspotted sculpin	0	0	1	0	0	7
	Cabezon	0	0	4	0	0	0
	Tidepool sculpin	0	1	0	1	1	1
	Sailfin Sculpin	0	0	0	0	0	2
	Sculpin spp.	9	1	0	0	0	1
Forage Fish	Sand lance	0	22	9	0	6	0
	Surf smelt	0	6	28	2	20	0
	Herring	1	8	10	6	5	0
Gunnels	Penpoint gunnel	10	0	46	5	2	29
	Crescent gunnel	2	1	36	0	1	28
	Saddleback gunnel	0	0	3	1	0	1
	Snake prickleback	1	14	76	0	4	2
	Gunnels spp.	0	2	0	6	1	0
Tubefish	Tubesnout	3	4	14	53	2	14
	Threespine stickleback	2	1	2	3	0	56
	Bay pipefish	0	0	0	1	0	1
Others	Skate spp.	2	2	3	1	0	2
	Rockfish spp	0	0	0	0	0	1
	Geenling spp.	1	1	2	0	1	6
	Cod spp.	0	1	3	2	0	0
	Midshipman	0	0	2	0	0	0
	Ratfish	1	0	0	0	0	0
Totals per Site:		3,615	3,786	6,492	2,423	1,045	1,188

Table 2 continued.

		Lincoln Park	Seahurst Park	Marine View	KVI	M. I. Park	Burton Park	Total per species
Salmon	Chum	449	110	124	336	290	33	2555
	Sockeye	2	1	1	0	0	0	112
	Cutthroat	5	19	10	2	1	1	210
	Steelhead	2	1	0	1	0	0	7
	Chinook	368	109	118	67	170	37	1135
	Coho	10	31	76	6	9	0	228
	Atlantic Salmon	0	0	0	0	0	0	1
	Total Salmonids	836	271	329	412	470	71	4247
Perch	Shiner perch	598	1454	2615	4932	1401	9362	33579
	Striped perch	100	0	0	0	0	0	299
	Pile perch	8	6	6	2	5	7	68
Flatfish	English sole	1	26	259	95	29	0	1568
	Rock sole	12	44	3	15	25	1	571
	Starry flounder	1	26	35	122	20	17	382
	Speckled sanddab	0	0	5	15	2	34	198
	CO sole	2	0	10	1	0	0	39
	Sand sole	0	0	1	0	0	0	7
	Flathead sole	0	0	0	0	0	0	3
	Pacific sanddab	0	0	0	0	0	0	8
	Sanddab spp.	0	0	0	1	0	0	2
	Flatfish spp.	0	0	2	18	0	0	119
Sculpin	Staghorn sculpin	17	34	74	785	38	118	1486
	Great sculpin	12	0	3	2	1	0	99
	Northern sculpin	0	0	5	4	10	0	41
	Buffalo sculpin	0	0	0	0	2	0	35
	Silverspotted sculpin	1	0	0	0	0	0	9
	Cabezon	2	0	0	0	0	0	6
	Tidepool sculpin	0	0	0	0	0	0	4
	Sailfin Sculpin	0	0	0	0	0	0	2
	Red Irish Lord	1	0	0	0	1	0	2
	Sculpin spp.	3	2	1	2	0	0	45
Forage Fish	Sand lance	4	765	315	101	290	0	1531
	Surf smelt	0	166	0	7	12	20	235
	Herring	1	5	1	8	371	7	485
Gunnels	Penpoint gunnel	38	1	6	0	0	0	113
	Crescent gunnel	27	0	3	0	0	1	36
	Saddleback gunnel	13	0	2	2	5	0	119
	Snake prickleback	5	0	13	0	0	3	30
	Gunnels spp.	0	0	0	0	0	0	90
Tubefish	Tubesnout	272	29	2	78	36	0	481
	Threespine stickleback	1	2	3	1	0	45	54
	Bay pipefish	5	2	9	0	1	4	31
Others	Skate spp.	0		1	0	0	0	2
	Rockfish spp	0	0	0	1	0	0	1
	snail fish	0	0	0	2	0	0	2
	Sturgeon Poacher	2	0	0	1	0	0	5
	Bay Gobi	0	0	0	0	0	2	3
	Geenling spp.	16	2	1	0	2	0	32
	Cod spp.	0	0	0	0	0	0	6
	Midshipman	0	0	0	0	0	0	2
	Ratfish	0	0	0	0	0	0	1
Totals per Site:		1,978	2,835	3,704	6,607	2,721	9,692	46,078

Table 3. Summary of all fish caught by site in 2002.

		Richmond Beach	Carkeek Park	Golden Gardens	Lincoln Park	Seahurst Park	KVI
Salmon	Chum	166	13	175	538	67	152
	Sockeye	4	0	0	0	0	0
	Cutthroat	6	6	8	9	12	1
	Steelhead	0	1	0	0	1	0
	Chinook	232	48	86	244	35	98
	Coho	78	23	30	61	9	2
	Pink	0	0	0	0	0	0
	Char	0	0	1	0	0	0
	Total Salmonids	486	91	300	852	124	253
Perch	Shiner perch	1526	1466	1801	1677	4148	1600
	Striped perch	19	15	58	27	1	7
	Pile perch	18	28	12	15	0	1
Flatfish	English sole	187	259	125	0	181	57
	Rock sole	19	30	8	16	75	14
	Starry flounder	23	37	9	3	36	420
	Speckled sanddab	49	18	2	0	2	3
	CO sole	4	0	2	0	0	0
	Sand sole	4	20	1	0	2	1
	Pacific sanddab	0	6	0	0	0	0
	Flatfish spp.	1	2	4	0	8	36
Sculpin	Staghorn sculpin	37	193	39	17	162	391
	Great sculpin	13	1	6	3	0	10
	Northern sculpin	0	0	4	0	3	1
	Buffalo sculpin	3	1	10	1	2	29
	Silverspotted sculpin	0	0	3	0	0	0
	Cabezon	0	0	3	0	0	0
	Tidepool sculpin	0	0	5	75	0	0
	Padded sculpin	1	15	7	4	11	73
	sailfin sculpin	0	0	0	0	0	1
	Sculpin spp.	20	20	6	110	31	25
Forage Fish	Sand lance	35	0	3	571	9	23
	Surf smelt	1	13	5	66	3	0
	Herring	12	2	6	4	11	1
Gunnels	Penpoint gunnel	29	7	16	3	1	6
	Crescent gunnel	5	5	14	3	0	14
	Saddleback gunnel	1	3	1	33	6	29
	Snake prickleback	0	0	1	0	4	3
Tube fish	Tubesnout	119	66	12	9	14	7
	Threespine stickleback	1	2	4	0	4	0
	Bay pipefish	0	0	1	3	5	2
Others	Skate spp.	3	4	0	0	1	1
	Geenling spp.	5	1	4	2	0	2
	Pacific tomcod	3	0	1	2	0	0
	N. Spearnose poacher	0	0	0	0	0	0
	Sturgeon poacher	0	0	0	0	2	17
	Rockfish spp.	0	0	1	1	0	1
	Arrow Goby	0	0	0	0	0	0
	Ratfish	0	0	0	2	0	0
Totals per Site:		2,624	2,305	2,474	3,499	4,846	3,028

Table 3 continued.

		DNR Beach 83	Pt. Robinson	M. I. Park	Burton Park	Talequah Point	Camp Sealth	Total per species
Salmon	Chum	398	0	649	15	0	5	2178
	Sockeye	0	0	0	0	0	0	4
	Cutthroat	1	4	1	2	1	14	65
	Steelhead	0	0	0	0	0	0	2
	Chinook	153	37	86	2	1	15	1037
	Coho	0	1	33	1	0	2	240
	Pink	0	0	63	0	0	0	63
	Char	0	0	0	0	0	0	1
	Total Salmonids	552	42	832	20	2	36	3590
Perch	Shiner perch	207	1280	1345	232	7	476	15765
	Striped perch	0	1	1	0	0	0	129
	Pile perch	0	3	4	8	0	0	89
Flatfish	English sole	0	11	175	0	0	37	1032
	Rock sole	0	10	11	0	0	6	189
	Starry flounder	21	25	55	1	0	14	644
	Speckled sanddab	0	0	0	1	0	0	75
	CO sole	0	0	0	0	0	0	6
	Sand sole	0	0	11	0	0	0	39
	Pacific sanddab	0	0	0	1	0	0	7
	Flatfish spp.	14	0	3	0	0	0	68
Sculpin	Staghorn sculpin	284	19	46	10	0	14	1212
	Great sculpin	0	3	1	0	0	0	37
	Northern sculpin	0	0	1	0	0	0	9
	Buffalo sculpin	0	5	28	0	0	1	80
	Silverspotted sculpin	0	0	0	0	0	0	3
	Cabezon	0	0	0	0	0	0	3
	Tidepool sculpin	0	0	0	0	0	0	80
	Padded sculpin	0	3	28	0	0	1	143
	sailfin sculpin	0	1	0	0	0	0	2
	Sculpin spp.	0	10	5	0	0	2	229
Forage Fish	Sand lance	1	0	357	0	0	0	999
	Surf smelt	0	0	1	1	0	2	92
	Herring	0	0	1	0	0	0	37
Gunnels	Penpoint gunnel	0	0	0	0	0	5	67
	Crescent gunnel	0	0	3	0	0	0	44
	Saddleback gunnel	0	6	19	0	0	8	106
	Snake prickleback	0	0	1	0	0	0	9
Tubefish	Tubesnout	0	5	5	0	0	65	302
	Threespine stickleback	1	0	0	1	0	0	13
	Bay pipefish	1	0	0	0	0	2	14
Others	Skate spp.	0	0	0	0	0	0	9
	Geenling spp.	0	1	0	0	0	1	16
	Pacific tomcod	0	0	0	0	0	0	6
	N. Spearnose poacher	0	0	0	0	0	1	1
	Sturgeon poacher	0	0	1	0	0	3	23
	Rockfish spp.	0	0	1	0	0	0	4
	Arrow Goby	0	0	0	34	0	0	34
	Ratfish	0	1	10	0	0	0	13
Totals per Site:		1,081	1,426	2,945	309	9	674	25,220

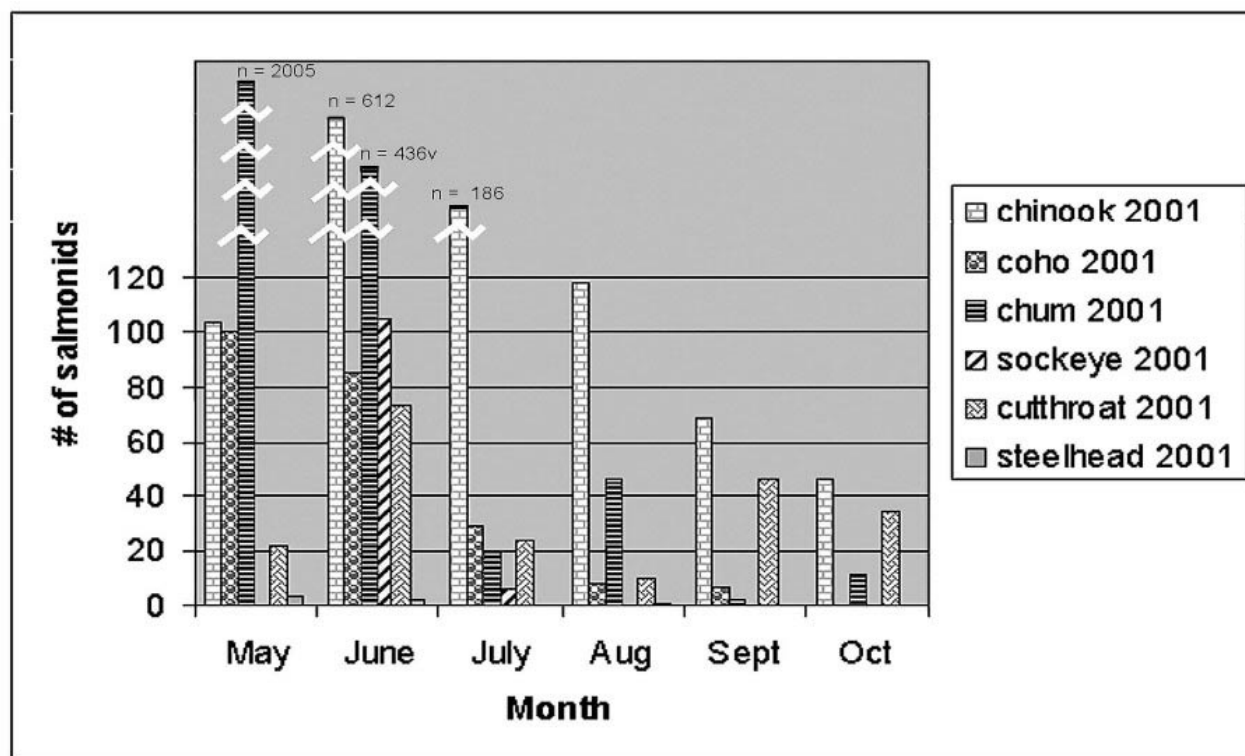


Figure 2. Number of salmonids caught by month in 2001.

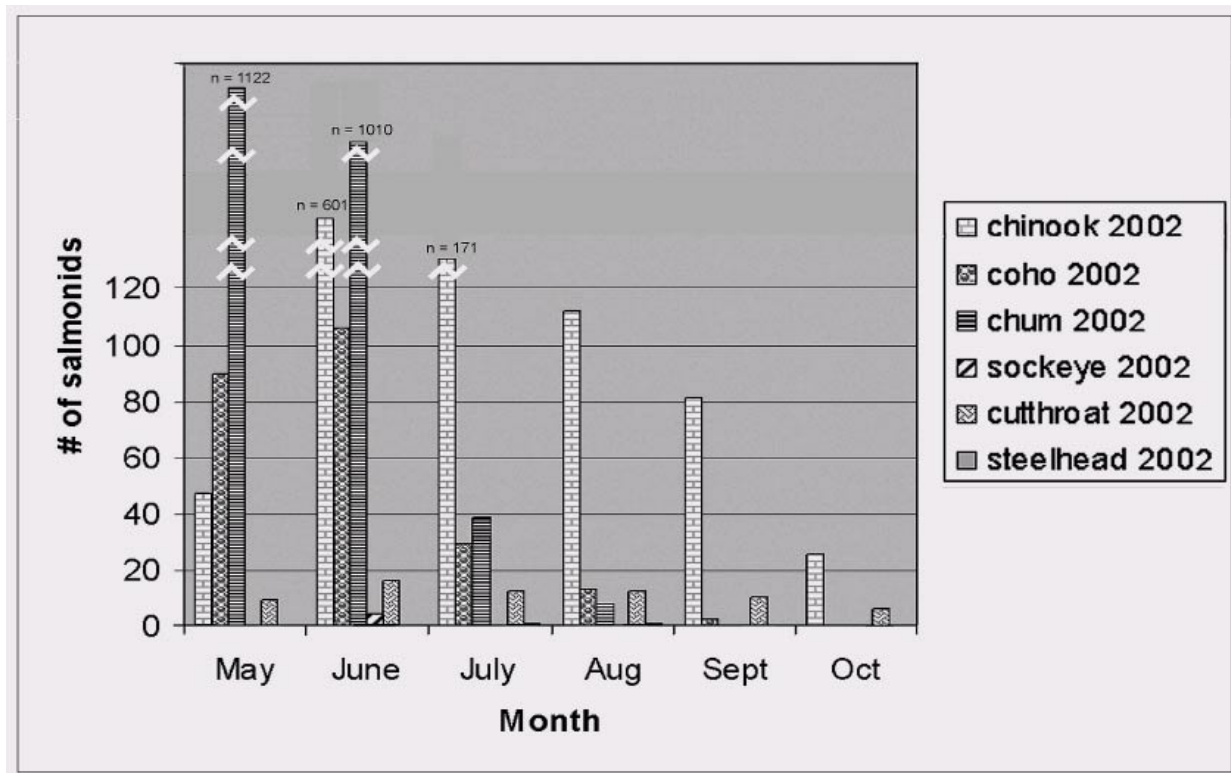


Figure 3. Number of salmonids caught by month in 2002.

Table 4. 2001 CWT chinook recoveries by sample site and hatchery of origin (*=1 cwt coho in the total).

Hatchery of Origin	Marble-mount Hatchery	White-Horse Pond	Bernie Gobin Hatchery	Wallace River Hatchery	Portage Bay Hatchery	Soos Creek Hatchery	Keta Creek Hatchery	Puyallup Tribal Hatchery	Voights Creek Hatchery	White River Hatchery	McAllister Hatchery	Tumwater Falls Hatchery	Grovers Creek Hatchery	Hupp Springs Rearing	Total CWT fish
capture location	WRIA 4	WRIA 5	WRIA 7	WRIA 7	WRIA 8	WRIA 9	WRIA 9	WRIA 10	WRIA 10	WRIA 10	WRIA 11	WRIA 13	WRIA 15	WRIA 15	
Carkeek	2	1	0	6	0	0	0	0	0	0	0	0	0	0	9
Meadowdale	0	0	0	*7	0	0	0	0	0	0	0	0	12	0	19
Ocean Ave	0	0	0	*1	1	0	0	0	0	0	0	0	2	0	4
Picnic Point	1	0	0	3	0	0	0	0	0	0	0	0	4	0	8
Richmond Beach	0	0	0	1	*1	1	0	0	0	0	0	1	1	0	5
Golden Gardens	0	0	0	2	0	3	0	0	0	0	0	0	0	0	5
totals	3	1	0	20	2	4	0	0	0	0	0	1	19	0	50
Burton Park	0	1	1	1	2	0	0	0	0	0	1	0	0	0	6
KVI	0	0	0	0	0	2	0	1	0	1	0	2	0	0	6
Maury Island	0	0	0	*6	0	*2	0	0	*1	0	0	0	0	1	10
Lincoln Park	0	0	0	11	0	19	0	0	0	1	0	0	0	0	31
Seahurst	0	0	0	13	1	0	0	0	0	0	0	0	0	0	14
Marine View	0	0	0	7	0	4	*1	0	0	0	0	0	0	0	11
totals	0	1	1	38	3	27	1	1	1	2	1	2	0	1	79

Table 5. 2002 CWT chinook and coho recoveries by sample site and hatchery of origin.

Hatchery of Origin and WRIA	Lummi Sea Ponds	Samish Hatchery	Marblemount Hatchery	Bernie Gobin Hatchery	Wallace River Hatchery	Issaquah Creek Hatchery	Soos Creek Hatchery		Keta Creek Hatchery		Elliot Bay Net Pens		Puyallup Tribal Hatchery	
							WRIA 9		WRIA 9		WRIA 9		WRIA 10	
	WRIA 1	WRIA 3	WRIA 4	WRIA 7	WRIA 7	WRIA 8	coho	chinook	coho	chinook	coho	chinook	coho	chinook
capture location	coho	coho	coho	coho	coho	coho	coho	chinook	coho	chinook	coho	chinook	coho	chinook
Richmond Beach	0	2	0	1	0	3	0	0	0	0	0	0	0	1
Carkeek	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Golden Gardens	0	0	0	0	0	1	0	0	0	0	0	0	1	0
WRIA 8 totals	0	2	0	1	0	4	0	1	0	0	0	0	1	1
WRIA 9	Lincoln Park	0	0	0	0	0	0	0	0	0	1	0	0	0
	Seahurst	0	0	0	0	0	0	0	0	0	0	0	0	0
	KVI	0	0	0	0	0	0	0	0	0	0	0	0	1
	DNR Beach 83	0	0	0	0	0	0	0	0	0	0	0	0	0
	Point Robinson	0	0	0	0	0	0	0	0	0	0	0	0	0
	Maury Island	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burton Park	0	0	0	0	0	0	0	0	0	0	0	0	0
	Talequah	0	0	0	0	0	0	0	0	0	0	0	0	1
	Camp Sealth	0	0	0	0	0	0	0	0	0	0	0	0	0
	WRIA 9 totals	0	0	0	0	0	0	0	0	0	1	0	0	2

Table 5 continued.

Hatchery of Origin and WRIA	Voights Creek Hatchery	White River Hatchery		Nisqually Hatchery		South Sound Net Pens		Port Gamble Net Pens		Grovers Creek Hatchery		Hupp Springs Rearing		Dungeness Hatchery		Total CWT fish		
		WRIA 10		WRIA 11		WRIA 14		WRIA 15		WRIA 15		WRIA 15		WRIA 18		coho	chinook	total
		coho	chinook	coho	chinook	coho	chinook	coho	chinook	coho	chinook	coho	chinook	coho	chinook			
WRIA 8		0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	38	
	Richmond Beach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	13	
	Carkeek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	13	
	Golden Gardens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	13	
	totals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	64	

WRIA 9		0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	28	
	Lincoln Park	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	
	Seahurst	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	
	KVI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	
	DNR Beach 83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	
	Point Robinson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	
	Maury Island	1	0	0	0	0	0	0	0	0	0	0	0	0	0	9	69	
	Burton Park	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Talequah	5	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7	
	Camp Sealth	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	totals	6	0	0	0	0	0	0	0	0	0	0	0	0	0	9	69	

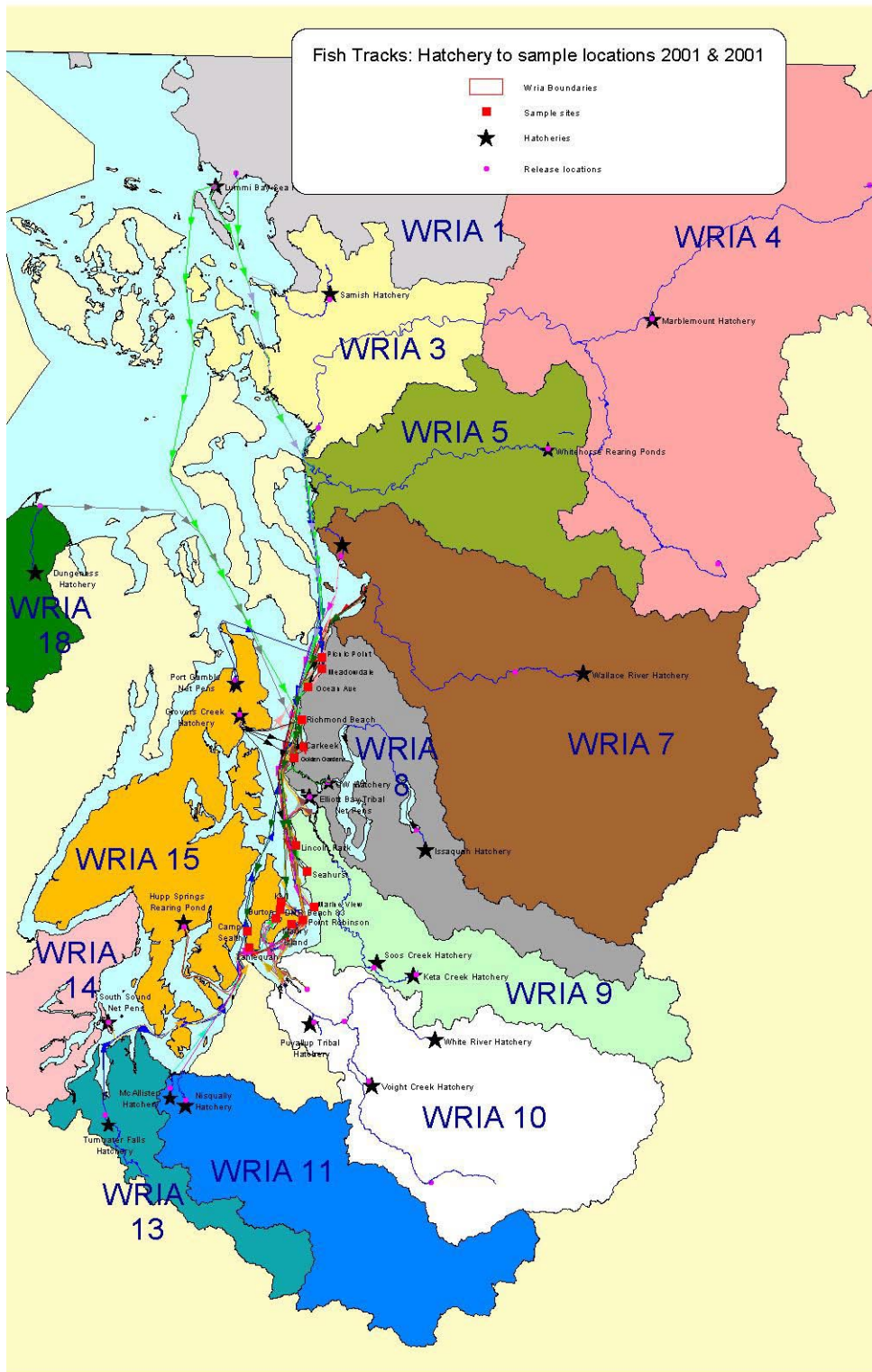


Figure 4. Map of Puget Sound and individual watersheds (WRIA's) showing points of release and recapture for CWT samples. Track Lines illustrate direction and a straight line of travel from hatchery/point of recapture.

A total of 934 stomach content samples (whole fish, stomachs, or lavage) were collected throughout the study period for dietary analysis. Chinook samples were collected at all sites and throughout the study, whereas other salmonid samples were collected when available and primarily early in the season. Early samples consisted primarily of whole fish due to the lack of lavage equipment and the desire to utilize CWT fish that were already being sacrificed for CWT extraction and decoding. Samples are currently being analyzed at the University of Washington and a report will be prepared upon completion of analysis for 2001 and 2002 samples from all sites surveyed. Expected results include identification prey type and composition, relative importance, frequency of occurrence and distinction of differences by site and seasonal occurrence. However, preliminary analysis, both quantitative and qualitative, indicates a diverse prey composition with a surprisingly high occurrence of terrestrial insects. Seasonal differences in prey composition were observed in the field (i.e., in lavage samples) and appeared to correspond with the availability of prey types (i.e., observed presence of certain prey types, such as insects, crab larvae and polychaete worms).

Discussion

As stated earlier, this report is intended to provide only a synopsis of our methods and preliminary results. Although we are very interested in identifying fish species composition and its variability throughout the region and over extended periods of time, this study provides at least a partial baseline representation of nearshore fish species assemblages for the sites sampled. The results presented here are primarily focused on salmonid data due to the ESA listings of chinook salmon and bull trout and the critical need for an improved understanding of their marine life histories.

Although we were unable to sample in every month of the year, it was interesting to note that juvenile chinook were found in our catch in every month sampled. There were also notable differences in species diversity and abundance at different locations, times of the year and at different tidal heights. For example, species diversity appeared higher at lower tides and juvenile salmonids were captured at all tidal elevations. Seasonal differences were also noted in prey type, abundance and availability (in the water), which seemed to correspond to the types of prey items found in lavage samples. This was particularly true for terrestrial insects, which varied seasonally in abundance. The most notable example of this occurred when there was a large hatch of tent caterpillar moths in 2002. Shortly after they appeared along the shorelines, we began finding them in the stomachs of juvenile chinook salmon. However, data are still being analyzed and these are simply qualitative observations.

The detection and collection of coded-wire tagged fish was originally integrated into our sampling program as a potential opportunity to distinguish hatchery from wild fish and to, possibly, learn more about movement patterns and growth. The results provide some of the more interesting and valuable data we collected. We were surprised to see the distribution patterns (i.e., in all directions) and the time “at large,” which, in some cases, was a very short period between release and recapture for the distance traveled. We are currently trying to calculate an estimated “sustained travel speed” for juvenile chinook and coho to determine if they are capable of traveling from the point of origin to the point of recapture (distance) for a known time at large. We are also attempting to determine if there may be other influences in their rate and direction of travel, such as currents. However, the data clearly indicate that juvenile salmonids use a substantial portion of the Puget Sound nearshore, both inside and outside of their watershed of origin. Although our data are only representative of hatchery fish, it is assumed that wild fish behave similarly and these findings have important implications for salmon management and recovery strategies.

The interpretation and utilization of mark/recaptured fish does present some problems. For example, current hatchery release practices make it difficult to determine point of release. While the marking (i.e., clipped) and tagging (i.e., CWT) of fish does provide some assurance that fish are of hatchery origin, not all hatchery fish are marked or tagged and limited numbers of wild fish are currently being marked and/or tagged for other management purposes. These practices limit our ability to make definitive conclusions about the composition of hatchery and wild salmonids in our catch. Having additional marking of fish, consistent hatchery release practices, improved record-keeping and broader-scale sampling to recapture tagged fish would be highly beneficial for an improved understanding of stock identification, growth, mortality and migration patterns.

The development and implementation of a nearshore beach seine survey program in King County proved to be highly successful and resulted in outcomes beyond our initial expectations. As with most research, the establishment of protocols and collection of consistent data was an evolving process. The types of data to be collected, data recording and storage, analytical methods, funding and general logistical issues presented challenges, which were resolved by adapting to each challenge as it arose. In the end, we have established a good baseline of nearshore fish species composition for the sites sampled. In addition, this program provided an opportunity to conduct training in addition to public education

and outreach opportunities. The fish species composition, diversity, lengths, weights, diet and identification of hatchery fish collectively provides a significantly higher level of information than we had previously and will be very useful for resource management, watershed and salmon recovery planning. Unfortunately, funding and logistical problems prevented us from completing a full annual cycle of sampling, which is important for filling data gaps for those months not sampled. We are hopeful that additional funds will become available for periodic sampling of different habitat types to learn more about the timing, distribution and habitat utilization of nearshore marine fishes in Puget Sound. For future studies, we would recommend that different sampling methods (i.e., trawling, fyke nets, impound nets) be used in conjunction with beach seining to sample further offshore, or provide data on the effectiveness (and bias) of beach seining for representing nearshore fish species assemblages.

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